AIR WAR COLLEGE

AIR UNIVERSITY

BACK TO THE MOON

BY 2001

BY

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A RESEARCH REPORT SUBMITTED TO THE FACULTY

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ABSTRACT

TITLE: Back to the Moon by 2001

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It has been more than 22 years since our last manned expedition to the moon. Since that time, our once pristine civilian space program, as represented by NASA, has atrophied into little more than a very expensive "Space Trucking System", occasionally dabbling in exploration. What NASA needs is an infusion of new life and a new challenge to get it back on track. The space program needs a directed purpose. Returning to the Moon to complete the scientific exploration started, and to exploit the rich resources of the Moon, particularly in nuclear and electrical power, is a doable/achievable, worthwhile goal. It can be done by forming an international space consortium to share costs, risks and benefits, and using off-the-shelf technology and hardware. The Space Shuttle will carry an advanced lunar module and crew capsule to Low Earth Orbit (LEO). A Russian Proton rocket will deliver a modified version of the Centaur Upper Stage booster into co-orbit with the Shuttle. They will rendezvous and the Centaur will propel the lunar module to the Moon. Subsequent activity will proceed similar to Apollo and the astronauts will return safely to Earth for direct entry. This system will allow establishment of a permanent lunar outpost and will serve as a test station for a follow-on mission to explore Mars.

BIOGRAPHICAL SKETCH

Lt Col John A. Kurtz (M.A., Central Michigan University) has been interested in manned space exploration since the early days of the Mercury Program. He is a 1976 graduate of the USAF Academy and is a Command Pilot with over 3600 flying hours in the B-52G and H. Lt Col Kurtz spent four years at Headquarters Strategic Air Command working as an aircraft and weapons test program manager for the B-1B. He is a 1991 graduate of the Air Command and Staff College, graduating in the top third of his class. He served as Operations Officer and, most recently, as Commander of the famed 96th Bomb Squadron, Barksdale AFB, Louisiana. Lt Col Kurtz is a graduate of the Air War College, class of 1995.

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INTRODUCTION

"Earth is the cradle of mankind, but man cannot live in the cradle forever."

Konstantin Tsiokovsky (1857-1935)
(Early Russian Rocketry Theorist)(1:1)

On December 19, 1972, the last of the intrepid Apollo explorers splashed down in the Pacific Ocean. Apollo 17 was the longest of the six lunar expeditions (301 hours, 51 minutes) and was the closing chapter of more than a decade of intense growth and development of our space program (2:267). In all, twelve men would walk on the moon, bringing back to earth scientific data that is still being studied 25 years later. "Then it was over! Finished! We haven't been back since. And we have no real plans to go back." (10:xi). Indeed, following Apollo, manned exploration of the cosmos quickly took a back seat to tend to "near earth" problems and developing the Space Transportation System (STS), commonly referred to as the Space Shuttle. After all, the clear goal of landing man on the Moon before the Soviets had been achieved. Further expenditures of resources could not be justified and the final two Apollo missions were canceled. The momentum and excitement of exploration, new discoveries and advances in technology soon gave way to a lifeless, bureaucratic fiscally-centered approach to our space program. Unfortunately, it took a disaster like the Challenger to bring this fact to public light (12:i).

The very mention of NASA used to bring to mind visions of exciting discovery, clean rooms and flawless attention to detail. It embodied everything that was good--the example of how to do things right. Today, NASA is essentially viewed as the caretaker of an expensive "Space Trucking System" that occasionally sends up a space probe. And of course, the flawed multi-billion Hubble Space Telescope did nothing but support this undesired new image.

What our once pristine space program needs now is an infusion of new life--a new challenge with new attainable, yet affordable, goals. On July 20, 1989, two decades after the first Apollo landing on the moon, President George Bush proposed a "long-range, continuing commitment" that would take the United States "back to the moon . . . back to stay," with the ultimate goal of landing man on Mars by 2019 (15). The ensuing program, called the Space Exploration Initiative (SEI), resulted in little more than studies about technologies required to make it a reality. SEI was, in true Washington fashion, studied to death (41:82). Unfortunately, politicians of today narrowly view space exploration as political suicide--a luxury that is easily cut with the budget knife. NASA refused to fund SEI out of their existing budget and Congress refused to appropriate any additional funding for it. With only half-hearted support from the White House the SEI was dead by the summer of 1991 (41:83).

It's time to reverse the inward-looking, stagnant trends of our space program and move it forward again. It's time to go back to the Moon, not just for political or pseudo-scientific purposes, but for real exploration and study of our sister planet. The Moon still has much to offer, economically, scientifically, and politically (3). The technologies and much of the hardware we need to return man to the Moon already exist. The First Lunar Outpost (FLO) is just around the corner and it is literally "off the shelf." What is needed is the will, political push and relatively modest financial investment to make it happen.

There are many good reasons for returning to the Moon to include economic, scientific, political, and future commercial ventures. The Moon holds the answer to our foreseen power crisis. Helium-3 will be mined and shipped to Earth to power fusion reactors; solar power grids will convert light into energy to be "beamed" to Earth; tourism will become a reality and untold mineral wealth may yet be discovered, but only if we look! Man has only scratched the surface in his understanding of the Moon, and hence, his understanding of the origin of the universe and his possible destiny. The Moon has yet to reveal many of these scientific secrets that only a detailed human exploration can uncover. Politically, a joint international venture, such as returning to the Moon, will unite the industrialized world under one shared purpose. In addition to keeping individual country costs lower, this venture will rally the human race toward this clear, lofty goal to expand man's knowledge and to exploit the wealth of the Moon.

A methodology will be proposed to return man to the Moon using existing hardware, technology and lift systems. Costs, launch schedules and proposed contractor timelines will be integrated into a realistic strategic plan with international cooperation. This endeavor will rekindle the fire of human imagination and will eventually lead to a permanent human presence on the Moon. It will also serve to restore some of the public trust, hope and inspiration that our atrophied space program once generated. And who knows, it may just be the vehicle by which the diverse peoples of our tiny island in space, called Earth, finally unite under one clear, shared purpose.

ECONOMIC BENEFITS

> **What do we want of the vast worthless area? This region of deserts, of shifting sands and whirlwinds of dust? To what use could we ever hope to put these deserts or these endless mountain ranges? What use can we have for such a place? I will never vote one cent from the public treasury.**
>
> **Senator Daniel Webster, opposing mail service to the Far West and California more than 125 years ago, in a speech before Congress** (11:56)

What Senator Webster lacked in this case was vision. Those who saw the future value of the west voted to instate the mail service and today we thank them for it--after all, where would Silicon Valley be without it? Unfortunately, we have our share of naysayers today who refer to the moon in the same context. In today's political game, if it can't happen within one's term of office, or will adversely affect his chances for reelection, it is not worth considering.

Initially, lunar resources will be used directly to support and build the permanent outpost. Once the outpost reaches a steady state, these technologies can be expanded for the benefit of the people stranded on Earth.

a. LUNAR OUTPOST: Establishing a human presence on the lunar surface will be the first priority. Prebuilt, modular habitats will initially house the explorers. Japan has taken the lead in the research and design of space station components. In fact, prototypes from this research already exist--they just need to be modified and soft-landed on the Moon (33:38). Plans even exist for using a spent space shuttle external tank as a lunar habitat (19:70).

Once established on the Moon, the process of self-containment will begin. The regolith will be processed to extract lunar oxygen for life support and propellant, iron and other metals for shielding and structures and glasses/ceramics for shielding and specialty uses (32:20). Food and plants will be grown in the lunar biosphere and the facility will expand to meet its growing needs. Solar power will run the whole show and losses of expendable materials (water, nitrogen and oxygen) will be replaced with relatively small extraction units (32:21). Once the outpost is running with very little, if any, sustaining support from Earth, the process of exploitation can begin.

b. NUCLEAR POWER: We now know that the lunar regolith is rich in Helium-3--the primary fuel of a clean nuclear fusion reactor currently being investigated by U.S., European and Japanese research scientists. It is estimated that a commercial fusion reactor will be on line in 20 years (30:10) and provide the following features (26:8):

1. High efficiency (70% conversion to electricity compared to 40% for fossil fuel and 33% for fission reactors).

2. Much easier licensing and sitting requirements compared to existing fission sites.

3. Environmentally friendly--less waste heat dumped into the environment; also, extremely low radioactivity of fuel eliminates transport and disposal problems we face today.

4. Safe--in the event of a catastrophic accident there would be no off-site fatalities even if all radiation were released at once. The feared "meltdown" would be impossible.

But why should we go to the moon for this material (30:10)?

1. It is nearly absent from the Earth as a natural resource.

2. Millions of kilograms are present in the lunar regolith, albeit at very low concentrations.

3. It could replace our dwindling supplies of fossil fuels we rely on so much today.

4. 20 tons of Helium-3 could supply the U.S. with electrical power for one year (less than one shuttle load). In 1987, the U.S. spent $40 billion on coal, oil, gas, and uranium to produce electricity. This makes Helium-3 worth approximately $2 million/kg and rising!

c. ELECTRICAL POWER: The Earth is headed for a power crisis of epic proportions (See Figure 1, page 8) (34:4). This will occur early in the new millennium. Studies conducted by NASA and the Department of Energy have confirmed the feasibility of collecting solar energy in space and transmitting this power to Earth via microwaves (37:50). Research in Russia and other countries extends this concept to the moon (23). Large banks of photovoltaic cells, constructed from the regolith, would collect the solar energy and channel it to a large microwave transmitter. Earth-side rectennas would capture the microwaves, convert them to conventional electricity, and distribute it. It is estimated that huge amounts of clean, safe energy (20,000 gigawatts) could be produced in this manner (38:50). Figure 2 on page 9 shows how this lunar power station will avert the power crisis (34:3). Also, a risk comparison of 21st century power systems can be found in Figure 3 on page 10 (34:2).

Engineering and cost models indicate that this Lunar Power System (LPS) is economically robust and can be built at a faster rate than all other power systems using existing technology.
Internal rates of return of 40% per year may be feasible (34:1).

d. MINING OPERATIONS: The major metals on the Moon are silicon, iron, calcium, aluminum, magnesium and titanium (30:8). At this time, the cost of mining these minerals and returning them to the Earth is prohibitive (14:61). However, as the more rare resources dwindle from the earth, and technologies to bring them back are refined, the situation may change. Some examples of these future technologies range from a Sub-Orbital Particle Ejector with Orbital Collection Vehicle (28) to an Electromagnetic Railgun injecting processed ingots at escape velocities in excess of one metric ton per hour (32:22).

The six Apollo expeditions found no appreciable outcroppings of precious stones like diamonds and ruby's on the Moon (13:181). However, the extremely small area covered by Apollo literally only scratched the surface. It is possible that once we return,

we may just find some of these exotic lunar minerals; perhaps even to the point of making a mining operation profitable.

To be sure, this level of lunar material exploitation is a long time off, but we can't begin to develop it without first getting there.

e. TOURISM: There will always people with enough personal resources to afford exotic and expensive trips. The future will be no different. If NASA offered up seats on shuttle flights for $1 million today, there would be people lined up at the ticket counter. Even though tourism to the Moon is also a long time into the future, it will some day be a reality and a profitable endeavor (27:45).

IN THE NAME OF SCIENCE

> **The most beautiful thing we can experience is the mysterious. It is the source of all true art and science. He to whom this emotion is a stranger, who can no longer rise to wonder and stand rapt in awe, is as good as dead; his eyes are closed.**
>
> **Albert Einstein, 1930** (11:208)

Throughout recorded history it has been the nature of the human animal to explore; to constantly reach out beyond his natural boundaries; to expand his knowledge and to answer questions pertaining to his very being. To stifle this instinct would indeed doom our species to a narrow, self-centered existence, and ultimately, to our extinction.

The Moon is still a virtually unexplored frontier. Despite the tremendous efforts put forth by the United States and the Soviet Union during the 1960s and 1970s to study the Moon, scientists still only have a rudimentary understanding of its structure and evolution (14:17). Scientific highlights of what we did learn include:

a. The Moon at one time experienced volcanic activity.

b. The Moon is much older than anticipated--4.6 billion years (about the same age of the earth).

c. There is no evidence that any type of organic life ever existed on the Moon.

d. The composition of the Moon is similar in terms of chemistry to the earth which points to a "family relationship."

This supports the theory that the natural laws of the cosmos are universally constant (11:208-221).

But, there are many questions about the Moon that remain unanswered that detailed explorations could help resolve (17:17):

a. Formation of the Earth-Moon system--Did the Moon form from the impact of a giant body with Earth or directly from accretion out of the primordial material?

b. Thermal and magnetic evolution of the Moon--What is the internal structure and thermal evolution of the Moon?

c. Bombardment history of the Earth-Moon system--What can the composition and other properties of the lunar craters tell us about the bombardment history of the Earth, the evolution of Earth's climate, and the evolution of life? It's important to know where you've been in order to predict where you are going.

d. Nature of impact processes--How do craters form and evolve? This could be extremely useful in light of recent comet fragment impacts on Jupiter. How would our planet react to such a cataclysm?

e. Regolith formation and evolution of the Sun--What can studies of the regolith, the blanket of broken rock and soil that covers the Moon, tell us about the evolution of the Sun? How can the regolith be used for building lunar structures?

f. Nature of the lunar atmosphere--What is the nature of the extremely tenuous lunar atmosphere?

g. Water on the Moon--It is possible that water could be found trapped in the soil at the poles? Could this be recovered and used to support a human colony on the Moon?

Additionally, the Moon offers an ideal setting for other scientific endeavors:

a. Large, permanent observatories--The Moon provides a nearly atmosphere-free environment, a large, solid platform, a cold, dark sky and the absence of wind. And, the far side of the moon is perfect for making sensitive radio observations free from interference emanating from the Earth. Astronomy conducted from a lunar base could examine the universe with 100,000 times more resolution than we currently observe--enough to directly observe planets orbiting distant stars and the presence of ozone (indicating abundant oxygen) in the atmospheres of these planets (35:5).

b. Space technologies/human psychology laboratories--Using the concept of walking before running, the Moon will allow man to safely mature technologies needed for deeper exploration, i.e., Mars. We will be able to build, test and refine robotic devices to aid in our lunar exploration and to give the Mars planners a higher level of confidence in

designing similar devices. From the human perspective, we will be able to safely study prolonged exposure to fractional gravity, and the effects of isolation in a confined habitat. Techniques to manage a biomass in an isolated environment will be refined as a logical and more realistic follow-on to the valuable Biosphere II experiments conducted in Arizona (37:255). Also, methods to protect humans from cosmic radiation and micrometeoroids will be perfected (14:18).

There are those who would argue that lunar exploration could be accomplished with robots. Indeed, robots will play a major role in future lunar exploration, but they have their limitations. A good example of this is the *Clementine* probe sent to the Moon to study its topography and gravitational fields. Even though *Clementine* was largely successful in its mission, a software glitch sent the spacecraft into a spin. The most exciting item on the spacecraft's agenda had to be scuttled--a close encounter with the asteroid Geographos (42:13).

Once these robotic limits are reached, man will be required to adapt and expand the limits. This becomes especially critical in the case of Mars where there is a two-hour time delay in communicating with Earth controllers. No matter how good we make our robotic devices, there can be no substitute for the flexibility, adaptability and intuitive nature of human observation. Man must eventually be on-site to make those critical decisions and to expand his frontier. For all the scientific reasons listed, we need humans back on the moon.

POLITICAL PROSPECTS

> **The aeronautical and space activities of the United States shall be conducted so as to contribute materially to . . . the preservation of the role of the United States as a leader in aeronautical and space science and technology.**
>
> **The National Aeronautics and Space Act of 1958** (14:97)

The U.S. space program has a long history of encouraging cooperative space activities--that is, as long as it was setting the agenda and terms of the ventures. As far back as 1958, international cooperation was mandated by the same Space Act that attempted to preserve the role of the U.S. as a leader in space activities (14:97). However, the early cooperative endeavors, such as Apollo-Soyuz, were shallow and political in nature, and did not yield much in the way of tangible benefits to either country.

Today, advances in space activities by Japan, the European Space Agency (ESA) (27) and Russia make international cooperation not only politically correct but can be truly

beneficial to all concerned in achieving the goal of returning man to the Moon. We need the experiences of Russian continuing long-term human presence in space on the *Mir* space station as well as their heavy lift resources (Energya). We need the great minds of ESA's *Lunar Study Steering Group (LSSG)* (27:3) and the leading edge robotics technology that Japan, Canada, France, Germany and Italy have to offer (14:100). Finally, the tremendous cost and complexity of space exploration mandates the need for international cooperation. No one country can bear the financial burden alone. Clearly, as a united international front, we can proceed with an exploration of the moon to (14:98):

a. Reduce costs for each participant

b. Synergistically increase overall technological capabilities and benefits

c. Extend opportunities for involvement in a wider variety of disciplines and spin-off technologies

d. Reaffirm U.S. global leadership in space

e. Increase the competitive posture of our partners, i.e., help to bring Russia out of its political/economic slump by fully exploiting and sharing lunar resources

It's easy to see that all participants will benefit from this synergistic pooling of resources and expertise.

We have come together before--we can do it again. In 1981, delegates from the Unites States, ESA, Japan and the Soviet Union met in Padua, Italy, to discuss ways to observe Haley's Comet from space. This *Inter-Agency Consultative Group (IACG)* rallied the expertise and resources of the participants. What followed was truly the epitome of coordination. The Soviets supplied two Venera probes in addition to the European Giotto space probe. The Unites States used its Deep Space Network to accurately track the probes and the comet. The resulting observations gave scientists their first close look at the nucleus of Haley's Comet and considerably reduced the positional uncertainty of the comet's path (24:CH 15). This cooperative effort was an unqualified scientific success and supports the notion that an international lunar expedition can work. Existing international arrangements such as the Moon Treaty and INTELSAT may provide the basis for future cooperation (29:170).

There is one more political aspect that needs to be addressed. The Earth is getting smaller every day. The time has come for the peoples of the world to form a common goal, to look beyond internal problems, even though significant, to continue to grow out in spite of the tendency to politically self-destruct around economic plight, military power and religious ideals. A joint exploration of the Moon could be the first step in getting the human race going in one direction with its long-term survival as its ultimate end.

UP, UP, AND AWAY--TODAY

Why can't we just revive and update the Saturn 5/Apollo program to return man to the Moon? This is a fair and frequently asked question, especially in light of the Saturn 5's perfect launch record and the availability of Apollo launch articles as well as the blueprints safely tucked away in the NASA archives (39:68). The answer is simply that we do not need to rebuild old, albeit proven, technology--we have the lift vehicles right now to do the job.

My first inclination was to use the Space Transportation System (STS) and take the space shuttle orbiter to lunar orbit, deploy and retrieve an advanced lunar module from the cargo bay, and return to Earth. What I discovered was that Rockwell International as well as other companies looked into flying the orbiter to the Moon. Even J.R. Thompson, when he was Associate Administrator for NASA, suggested taking the orbiter to the Moon and back. The idea was dismissed without much study for the following reasons (22):

a. Too heavy
b. Too costly, to qualify and dedicate an orbiter
c. Subsystems are not designed for that long a mission
d. Subsystems are not redundant enough to be safe for a 30 day waiting period to rendezvous with an orbiting station or External Tank (ET)--if you don't have direct reentry. This approach is also very uncertain and unfriendly to mission delays.
e. Direct reentry adds even more weight for thermal protection and very expensive for qualification of such

However, Rockwell International (20) and General Dynamics (17) both studied using the STS to take lunar vehicle components to Low Earth Orbit (LEO). I will use the results of these studies coupled with other existing lift systems as the basis for this plan.

CONCEPT OF OPERATIONS

Man can return to the Moon with off-the-shelf technology as follows: A Space Shuttle will takeoff in a standard flight configuration with a new General Dynamics developed Lunar Excursion Vehicle (LEV) in the aft cargo bay (16:42). A crew capsule, similar to Apollo, will be positioned in the forward cargo bay (separated because of volume constraints).

The shuttle will attain a parking orbit at an altitude of 115 miles and a speed of 17,600 (4:46,57) and wait for a Russian Proton to lift off with a modified version of General Dynamics Centaur G-Prime upper stage as its payload. The shuttle will rendezvous with the Centaur and two astronauts don their space suits, enter the cargo bay and board the crew capsule. Two more astronauts will go EVA to deploy the LEV and

the crew capsule and assist in docking the two vehicles. The mated LEV will then dock with the Centaur.

After a thorough systems checkout the Centaur will propel the LEV on its Trans-lunar Insertion (TLI) at a speed of 25,000 MPH, similar to the Saturn V third stage (5:31), and then be jettisoned. The LEV will enter lunar orbit and use its four main engines to land at the pre-selected site. Exploration will proceed similar to Apollo.

Unlike Apollo, there will be no Command Module in lunar orbit with which to rendezvous. The LEV will be self-contained, lifting off from the lunar surface and propelling its way back to Earth at a speed of 5,000 MPH (8:40,76). Upon reaching the vicinity of Earth, the crew capsule will disengage from the LEV and directly reenter for a splashdown--mission complete. This all sounds fairly straight-forward but how feasible is it?

FEASIBILITY

Each component in this lift system will be discussed to determine if it can work from an engineering standpoint. Payload volume and weight capacities as well as total thrust versus mass will be analyzed. I will keep the discussion simple by using comparisons from the Saturn V/Apollo thrust versus mass requirements.

a. NEW SYSTEMS: The only totally new system required will be the LEV. The lunar module from the Apollo program was approximately 14 feet in diameter, 23 feet long (5:63) and weighs in at just over 32,000 pounds (5:105). Obviously, a simple resurrection of the old lunar module would do the job. However, the new LEV proposed by General Dynamics is vastly improved over the 1960s technology and will have the capability to soft-land equipment, supplies or humans on the Moon. The LEV will also be able to takeoff from the lunar surface and bring payloads back to Earth. It will be approximately 35 feet in length and 14 feet wide (folded) which will fit neatly into the aft shuttle cargo bay. Its lightweight, composite construction will make the LEV ideal for shuttle transport. See Figure 4 on page 21 (17:10).

Figure 4

b. DERIVATIVES OF EXISTING SYSTEMS (17:9):

1. CREW CAPSULE: This will be similar to the Apollo crew module, but will be smaller (only two astronauts) and lighter (composite materials and micro-electronics). The Apollo crew module was 12 feet in diameter (5) so I will assume that the new, smaller

capsule will fit in the forward shuttle cargo bay area. Refer back to Figure 4 for a depiction of the crew capsule mounted on top the LEV.

2. LUNAR HABITAT/CARGO MODULE: This will be derived directly from a Space Station Freedom pressurized logistics module. It can be mated to the LEV to carry cargo to the Moon and/or be used as a larger habitat for the astronauts. These modules are also ideal for shuttle transport as they were predesigned to fit in the shuttle cargo bay.

c. EXISTING SYSTEMS

1. SPACE SHUTTLE: There will be no modifications required to the STS launch system. The shuttle cargo bay is 60 feet long, 15 feet wide and can lift a 65,000 pound payload to LEO (1:39). The following payload weight will be lifted (17:10):

LEV DRY WEIGHT	7,500 lbs
PROPELLANT WEIGHT	37,750 lbs
CREW CAPSULE WEIGHT	7,200 lbs
CREW/EQUIPMENT WEIGHT	750 lbs
TOTAL PAYLOAD WEIGHT	53,200 lbs

As you can see, this payload can be inserted into LEO using the Space Shuttle. The only problem I can see here is the carrying of cryogenic propellants in the shuttle cargo bay (prohibited since 1986 due to safety concerns) (40:290). However, the orbiter has provisions to jettison all cryogen's in a matter of seconds if an emergency would arise. In any case, this is one safety concern that would have to be resolved.

2. CENTAUR G-PRIME UPPER STAGE: The Centaur G-Prime is a liquid propellant, twin engine booster, designed to take payloads from LEO to Geostationary Earth Orbit (GEO). It is 30 feet long, 15 feet wide and weighs 36,400 pounds fueled. Its twin RL-10 engines produce 30,000 pounds of thrust for 473 seconds (16:45,40:289).

The General Dynamics derivative Centaur version will be a single-engine vehicle, on which studies have already begun for use on satellite injection missions (16:45). The uprated RL-10 will produce 35,000 pounds of thrust for 617 seconds (40:298). A payload and docking adapter (for the LEV) will also be added as well as minor changes necessary for man-rating the Centaur. Weight for the existing Centaur is 6,000 pounds plus 30,400 pounds of propellants (40:289). I will assume the new upgraded Centaur to weigh a total of 40,000 pounds including propellants.

The total payload in LEO to be sent on the journey to the Moon will be the LEV/CREW CAPSULE (53,200 lbs) and the new CENTAUR (40,000 lbs) for a total of 93,200 lbs. In comparison, the Saturn V Third Stage weighed 368,550 pounds prior to TransLunar Injection (TLI) (5:105). It's J-2 engine took 225,000 pounds of thrust 312 seconds to accelerate this mass to 25,000 MPH (7:99). In our example, we have 25% of

the TLI mass, 16% of the thrust available but almost double the burn time. Without wading through the integral calculus equations it's safe to say, using this comparison, that the Centaur/LEV combination is feasible once it gets to LEO!

3. PROTON LIFT VEHICLE: There are at least three possible lift vehicles on the market today to orbit the Centaur upper stage. They are the Titan IV, the French Ariane and the Russian Proton. All of these systems are extremely reliable. The primary reason for selecting the Proton was cost. See table below:

LIFT VEHICLE	COST PER LAUNCH (1991 $)
Titan IV	$ 110 Million (40:294)
Ariane	$ 80 Million (40:227)
Proton	$ 60 Million (40:345)

Secondary reasons for choosing the Proton are to "walk the talk" regarding international cooperation and to give Russia a real stake in the project. Since it is US policy to help Russia stand up her new democracy, the choice of the Proton will save us money while helping Russia's economy and political prestige on the world scene.

The Proton SL-13 is a three-stage, liquid fueled rocket capable of lifting over 45,000 pounds to LEO (40:341). Launch reliability in its 25 flights up to 1990 was 100% (40:345)! There should be no problem getting the Centaur to LEO with the Proton.

We've shown why we should go back to the Moon and that we have the technologies and lift systems to do it before the end of the millennium. Our final piece of the puzzle would be a roadmap, strategic plan to include timelines and that all important ingredient--<u>money to make it a reality!</u>

A LUNAR STRATEGIC PLAN

To begin with, I recommend an international consortium be formed consisting of the following countries: the United States, Russia, Japan, France, Germany and Italy. These countries, the world's foremost leaders in space and technology related fields, will form the core of the GLOBAL SPACE CONSORTIUM. (Of course, additional membership will be limited only by what the prospective member can bring to the collective table.) They will draw up the lunar exploration charter and set the agenda. Each country will "pitch in" 2 % of their space budget annually through 2001--they will also reap a corresponding percentage of industrial contracts. When lunar exploitation moves into the black they will also reap their percentage of the profits (payback for their up-front risk). See figure 5 below for lunar cost sharing. (NOTE: All figures are in millions of U.S. equivalent dollars with a 5% annual inflation rate) (40):

FISCAL CONTRIBUTIONS TO GLOBAL SPACE CONSORTIUM

(millions of U.S. dollars)

COUNTRY	1996	1997	1998	1999	2000	2001	TOTAL CONTRIBUTION
U.S.	836	878	922	968	1016	1067	5687
Russia	186	195	205	215	226	237	1264
Japan	30	32	34	36	38	40	210
France	44	46	48	50	53	56	297
Germany	34	36	38	40	42	44	234
Italy	14	15	16	17	18	19	99

TOTAL LUNAR EXPLORATION FUNDS AVAILABLE $ 7791 M

Figure 5

The NASA budget will need to be increased by at least 1 % real growth annually. Of course, this is contrary to President Clinton's proposed $5 billion cut in the NASA budget--these cuts will have to come from some pork-based areas of our federal beaurocracy. The remaining 1 % can be funded out of the current NASA budget by "piggybacking" certain planned missions with lunar missions and restructuring NASA to bring it back to the lean efficiency of the Apollo days (35:10).

Costs of returning man to the Moon are depicted in Figure 6 on page 25. All figures are in millions of projected U.S. dollars in the year 2001.

ACTIVITY	PROJECTED COST
2 Shuttle Launches	$ 772 (40:72)
2 Proton Launches	$ 162 (40:345)
General Dynamics R D & A	$6000 (16:45)
Crew Capsule	
LEV	
Habitat Module	
Space Suits	

TOTAL PROGRAM COST $ 6934 M

Figure 6

This $ 6934 cost figure is well within the budget of the GLOBAL SPACE CONSORTIUM. The additional funds may be used for the acquisition of scientific equipment and to absorb any cost overruns.

It will take approximately 6 years for the development and production of the LEV, Crew Capsule, Lunar Surface Utilities, Centaur Upgrades, Lunar Habitat Module and the Lunar Science Equipment (17). If we turned on the contractor by the Summer of 1995, we will have everything in place for a Fall, 2001, launch. Space Shuttle and Proton launch schedules are still soft enough to allow this mission to be scheduled.

MISSION PROFILE

Early in October, 2001, a Space Shuttle will takeoff with a LEV in the aft section cargo bay and a Habitat/Cargo Module in the front. In the Habitat/Cargo Module will be supplies and equipment for a 20 day stay on the Moon. Twenty-four hours later, a Russian Proton will lift off with the modified Centaur Upper Stage on board. The shuttle will rendezvous with the Centaur, and deploy the Habitat Module and the LEV. Astronauts will go EVA to mate all three vehicles together. After a thorough systems checkout and at the appropriate time, the combined vehicle will perform a TLI burn and proceed to the Moon. The shuttle will be free to perform other aspects of its mission profile. The LEV/Habitat Module will automatically soft land at the pre-selected site on the Moon. Also, since this vehicle will not return to Earth, it will have the capability to be used by the astronauts as a lunar transport vehicle, performing short hops to local areas of interest.

Once the lunar site is prepared, another Shuttle/Proton combination will takeoff, this time with a Crew Capsule and two lunar-bound astronauts. LEO activities will be similar to the first launch. When the astronauts arrive at their landing site they will be all set for a 20 day, detailed exploration of the Moon. When complete, their LEV will lift off and proceed back to Earth. The Crew Capsule will detach from the LEV and reenter as previously discussed.

But it doesn't have to end here. This site can be expanded with additional manned/cargo visits to establish a lunar outpost (18) for a long-term human presence on the Moon.

CONCLUSION

. . . not because it will be easy, but because it will be hard--because it will serve to organize and measure the best of our energies and skills--because the challenge is one we are willing to accept, one we are unwilling to postpone.

President John F. Kennedy, 1962 (11:46)

This is what happens when real leadership steps in to set lofty national goals as well as provide the means to make them a reality. It's easy to set goals: the National Aerospace Plane (President Reagan) and the Space Exploration Initiative (President Bush) both sounded good; however, neither program was followed up with the funding required to bring them to fruition. It's time to end these feeble, hollow attempts to get our space program back on track. It's time to excite once again the human spirit with a realistic, attainable and affordable goal of returning man to the Moon by 2001.

We showed the scientific and political benefits to be real. The economic possibilities, especially in the way of power resources, are incalculable. We discussed a way in which we can return to the Moon by 2001 using known technology and verified its feasibility. Finally, we put it all together in an international effort and showed how it could be financed without overburdening any one country.

It's easy to look back and see who the visionaries were. What is difficult is to look ahead, imagine the possibilities, set your goals and go after them with a purpose. That is what this country needs of its leadership and that is all it needs to return to the Moon. The know-how and the tools we need are already here.

It doesn't take a "rocket scientist" to realize that one day we will have to leave our cozy little planet. Why not prepare for that day now?

BIBLIOGRAPHY

1. Torres, George. Space Shuttle: A Quantum Leap. Novalto, CA: Presidio Press, No date.

2. Young, Hugo. Journey to Tranquillity. New York: Doubleday and Company, Inc., 1970.

3. Ruzic, Neil P. The Case for Going to the Moon. New York: G. P. Putnam's Sons, 1965.

4. Stine, Harry G. Shuttle into Space. Chicago: Follett Publishing Company, 1978.

5. Booker, P. J. Project Apollo: The Way to the Moon. New York: American Elsevier Publishing Company, Inc., 1969.

6. Hallion, Richard P. Apollo: Ten Years Since Tranquillity Base. Smithsonian Institute Press, 1979.

7. The Apollo Program. North American Rockwell Corp., 1968.

8. Sparks, James C. Moon Landing: Project Apollo. New York: Dodd, Mead and Company, 1969.

9. Kaplan, Marshall. Space Shuttle. Fallbrook, CA: Aero Publishers, Inc., 1978.

10. McKinnon, Douglas, and Baldanza, Joseph. Footprints. Washington, DC: Acropolis Books, Ltd., 1989.

11. Shelton, William R. Winning the Moon. Boston: William, Brown and Company, 1970.

12. Trento, Joseph J. Prescription for Disaster. New York: Crown Publishers, Inc., 1987.

13. Cadogan, Peter H. The Moon--Our Sister Planet. London: Cambridge University Press, 1981.

14. Brown, George E. Exploring the Moon and Mars. Washington, DC: US Government Printing Office, 1991.

15. George Bush, "Remarks by the President at 20th Anniversary of Apollo Moon Landing," The White House Office of Press Secretary, July 20, 1989, p. 3.

16. "GD Goal: Lower-cost Manned Lunar Missions." *Aviation Week and Space Technology* (January 18,1993) pp. 42-45.

17. "Early Lunar Access." *General Dynamics Program Overview* (December, 1992).

18. "This Time to Stay." *Final Frontier* (January, 1993) pp. 40-43.

19. "Lunar Habitat Would be Assembled in Space." *NASA Tech Briefs* (August, 1992) p. 70.

20. "Shuttle Launched Manned Lunar Missions." *Rockwell International Study* (Undated).

21. David C. Webb, Ph.D., 152 Gray Dove CT, Daytona Beach, FL

22. Mr. Ardell W. Nease, Rockwell International, Director, Space Shuttle/Space Station Business Area

23. "Elektrostantzee na Lune." *Pravda* (Feb, 1995) (Russian article in Pravda on proposed lunar power station).

24. Johnson-Freese, Dr. Joan. Changing Patterns of International Cooperation in Space. Malabar, FL: Orbit Book Company, 1990.

25. Trip Report of Space Conferences, Toronto, Canada, May, 1994.

26. "Astrofuel for the 21st Century." Report by the College of Engineering, University of Wisconsin, March, 1988.

27. European Space Agency. Return to the Moon. Sep, 1991.

28. "To the Moon and Beyond." Briefing by Rockwell International Space Systems Division, Apr, 1990.

29. Report of NASA Lunar Energy Enterprise Case Study Task Force, *NASA Technical Memorandum 101652*, Jul, 1989.

30. "Using Space Resources." *NASA Johnson Space Center*, 1991.

31. "Lunar Outpost." *NASA Johnson Space Center*, 1989.

32. "The Case for an International Lunar Base." *International Academy of Astronautics*, Sep, 1987.

33. Lowman, Paul D. Lunar Bases: A Post-Apollo Evaluation. Greenbelt, MD: Goddard Space Flight Center, 1985.

34. Criswell, David R. and Waldron, Robert D. Lunar System to Supply Solar Electric Power to Earth. San Diego, CA: 1990.

35. Hawkins, Willis. New Directions in Space. Washington, DC: George C. Marshall Institute, 1990.

36. "US Draws Blueprints for First Lunar Base." *Aviation Week and Space Technology,* (August 31, 1992) pp. 47-51.

37. "Biosphere II: 3800 Species Under Glass." *Air War College Space Thematic Courseware*, Sep 94.

38. "Journal of Practical Applications in Space." *Air War College Space Thematic Courseware,* Sep 94.

39. "Reviving Saturn V May be NASA's Best Option to Obtain Heavy-Lift." *Aviation Week and Space Technology,* (20 May 91), p. 67.

40. Wilson, Andrew. Space Directory. Alexandria, VA: Jane's Information Group, Sentinal House, 1991.

41. "Doomed to Fail: The Birth and Death of the SEI." *Spaceflight*, (March, 1995) pp. 79-83.

42. "Darling Clementine?" *Scientific American,* (August, 1994) p. 13.

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